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ANALYZING VISUAL ATTENTION TO REPEATED PRINT ADVERTISING USING SCANPATH THEORY

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SOM theme B: Marketing and Networks

Abstract

Consumers' visual attention to a repeated print advertisement is examined using eye-tracking methodology. We propose a statistical model comprising submodels for three key measures of visual attention to specific elements of the advertisement: attention onset, attention duration, and inter- and intra-element saccade frequencies. These measures are vital in understanding the impact of repetition on advertising effectiveness, but have not been considered in previous research. Our analyses show that whereas attention duration decreases and attention onset accelerates during each additional exposure to the print ad, the attentional scanpath remains constant across advertising repetitions and across experimentally varied conditions. This scanpath obeys a stationary, reversible first-order Markov process.

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Most research on advertising repetition (e.g., Anand and Sternthal 1990; Belch 1982; Berger and Mitchell 1989; Haugtvedt et al. 1994) is based on Berlyne's (1970) two-factor theory (see also Cacioppo and Petty 1979), which proposes a nonmonotonic inverted-U relationship between advertising exposure and affect toward the ad. This relationship is caused by two opposing factors. On the one hand, positive habituation (or opportunity) leads to an increase in affect, with diminishing returns of each additional exposure; on the other hand, satiation (or tedium), which sets in after the first exposure, leads to a progressive decrease in affect. The two-factor theory has stimulated many studies examining the moderating role of advertising characteristics such as ad length, ad complexity or difficulty, and ad variations (Anand and Sternthal 1990; Cox and Cox 1988; Haugtvedt et al. 1994; Rethans, Swasy and Marks 1986), and of consumer characteristics such as prior knowledge, brand familiarity and motivation (Batra and Ray 1986; Rethans, Swasy and Marks 1986; Tellis 1988).

Although past research has contributed considerably to understanding the effectiveness of repeated advertising, we believe that progress can still be made in at least two directions. First, more insight into the processes giving rise to the effects of repeated advertising is needed. In the two-factor theory and related models (e.g, Cacioppo and Petty 1979), the key dependent variable is overall liking of the ad or attitude toward the advertised brand, and the emphasis is on cognitive processes intervening between exposure and liking (Belch 1982; Haughtvedt et al. 1994). So far, research on the impact of advertising repetition on attention is rather limited. This is surprising given the central role of attention in advertising communication processes (Rossiter and Percy 1983; Shanteau 1983), particularly in advertising wearin and wearout across repetitions (e.g., Craig, Sternthal and Leavitt 1976; Batra and Ray 1986; Henderson Blair 1987; Pechmann and Stewart 1989). Calder and Sternthal (1980) argue that inattention is a major cause of repeated advertising's wearout; i.e., with increased repetition consumers pay progressively less attention to ads. The contention receives indirect support in research that shows a decline in brand name recall when advertising repetition increases beyond some threshold (Craig, Sternthal and Leavitt 1976), but empirical support based on direct measures of attention is scarce (cf., Unnava and Burnkrant 1991). This study is the first to analyze visual attention to repeated advertising using eye-tracking methodology. The methodology allows us to closely examine specific patterns of visual attention to key elements of ads, and to examine if and how these patterns change across advertising repetitions.

A second avenue for potential progress concerns the role of advertising exposure situations and specific characteristics of the advertising stimuli used in repetition research. To date, research on advertising repetition has typically used television commercials (Axelrod 1980; Batra and Ray 1986; Belch 1982; Calder and Sternthal 1980; Haugtvedt et al. 1994; Hughes 1992; Rethans, Swasy, and Marks 1986) that have fixed, externally controlled exposure durations. In contrast, consumers control exposure duration to print advertising themselves, which offers them a way to adapt to advertising repetition by reducing the exposure duration. The few studies on repetition of print advertising have typically either examined advertising under fixed exposure durations (e.g., Berger and Mitchell 1989; Unnava and Burnkrant 1991) or have not measured exposure durations (e.g., Cox and Cox 1988). As a consequence, little is known about the effect of repetition on attention to advertising for which exposure duration is under consumer control, such as print advertising, outdoor advertising, and yellow pages.

This study examines the effect of repetition on consumers' attention to print advertising, using eye recordings as measures of visual attention. Consumers determine the total exposure duration to the print advertisement during each exposure. Instead of focusing on overall measures of memory or liking, we examine measures of attention to the key elements of the advertisement: headline, pictorial, bodytext and packshot. Consumers' motivation to attend to print ads and the quality of arguments in the ads are systematically manipulated to establish generalizability of the impact of repeated advertising across relevant stimulus and consumer conditions (Batra and Ray 1986). A stochastic model is proposed that enables detailed analyses of attention duration, attention onset and inter- and intra-element saccade frequencies for repeated advertising. In this way insight is obtained into patterns of visual attention that have not been examined previously, but that seem crucial to understand processing and effectiveness of repeated print advertising.

Repeated advertising and visual attention

Eyes go where attention is directed (Henderson 1992) and, therefore, eye-tracking data form a reliable measure of consumers' visual attention to advertisements (Krugman et al.

1994; Krugman 1965; Van der Heijden 1992). Apart from several smaller, corrective eye movements, eye-tracking data are composed of fixations and saccades. During saccades, or the quick jumps of the eye from location to location, vision is essentially suppressed (Sperling and Weichselgartner 1995; Wirtschafter and Weingarden 1988). Fixations, or the pauses between saccades during which the eye is relatively immobile, are the more important aspect of visual attention (Loftus 1976), and the evaluation of an ad's potential to gain attention should be based on the duration, position and pattern of those fixations (Viviani 1990).

Typically, in basic research on reading (e.g., McConkie 1983; Rayner 1995) and on visual scanning (e.g., Loftus 1983; Schneider and Deubel 1995) fixations are analyzed at the most disaggregate level, at which the exact position and duration of each individual fixation is retained. There are several advantages to analyzing fixations at a more aggregate level, where fixations are assigned to areas instead of retaining their exact positions, when studying visual attention to print advertising. First, at each fixation the visual field covers both foveal vision, as expressed through fixation locations, and parafoveal vision. Since a larger part of the ad is attended to during each fixation than is suggested by exact fixation positions (Loftus 1983), predefined areas of the advertisement are more appropriate as the unit of analysis than exact fixation points. Second, the focus in advertising development and in subsequent copy testing is often on relevant advertising elements rather than on exact physical locations. Usually, the goal is to understand whether and how frequently consumers attend to ad elements, such as brand name, product, headline and pictorial, rather than to know the exact coordinates of consumers' fixations in, for instance, the headline. Finally, methods to analyze the complete sequences of fixations require specification and analysis of saccades between all fixation points (Ellis and Smith 1985; Stark and Ellis 1981). Given the number of fixations and saccades that occur during a single exposure to an ad, the dimensionality of this problem becomes prohibitively large when it is based on exact fixation positions instead of fixations on a limited number of areas.

Although some aggregation of raw eye-tracking data is thus desirable, an appropriate level of aggregation has not been suggested in the literature to date. At the most aggregate level, only the total amount of time subjects attend to each area (i.e., attention duration per ad element) is retained from the raw eye-tracking data. Previous advertising research typically has used such aggregated data to study the impact of ad characteristics on visual attention (e.g., Celsi and Olson 1988; Janiszewski 1993; Krugman et al. 1994; Rosbergen, Pieters, and Wedel 1997). As a consequence such studies could not examine which patterns of attention can be discerned from eye fixations, because detection of such patterns requires information about saccades between elements of the ad.

At an intermediate level of aggregation, individual fixations are assigned to specific ad elements, so that information on inter- and intra-element saccades, or area-to-area saccades, is still available (cf., Russo and LeClerc 1994). We present a model to analyze such intermediate level eye-tracking data for print advertisements and to examine regularities in fixation patterns. Moreover, the model accounts for the impact of repetition and exogenous variables on those patterns. Before presenting the model, we first formulate hypotheses about the attentional patterns of consumers who are exposed repeatedly to a print advertisement.

Hypotheses

Typically, attention to a TV-commercial has been found to initially increase with repeated exposures, but to decline usually after two or three exposures (e.g., Cacioppo and Petty 1979; Calder and Sternthal 1980; Belch 1982; Grass and Wallace 1969). However, since TV is primarily an externally-paced medium, where consumers do not control exposure duration, it is not obvious that such a pattern will also hold for internally-paced media, such as newspapers and magazines. That is, with externally-paced media, one exposure to an advertisement may not be sufficient for consumers to fully comprehend its content and message, in which case additional exposures are needed. This situation is increasingly likely to occur given the reduction in the average length of TV-commercials nowadays (e.g., Kent 1993). With internally-paced media, on the other hand, consumers can move to the next page the moment they sufficiently understand the ad's content or no longer want to attend to the ad. Several researchers have argued that for print advertising one exposure may suffice to communicate its message (Calder and Sternthal 1980; Krugman 1972). As a consequence, the amount of attention paid to the ad is likely to decline after the first exposure. The reduction in attention duration will be accompanied by a reduction in "attention onset," the amount of time between the start of an exposure to the ad and the moment that subjects attend to a specific ad element for the first time. That is, since a glimpse of an ad element suffices to indicate its familiar content, subjects would spend less time on that element and attend earlier to the other ad elements. In sum, we offer the following hypotheses:

H_1: The duration of attention to a print advertisement and its elements decreases across repeated exposures to the ad.

H_2: The onset of attention to the elements of a print advertisement accelerates across repeated exposures to the ad.

Basic research on eye movements during repeated exposures to the same picture (Groner 1988; Noton and Stark 1975; Stark and Ellis 1981) suggests that sequences of fixations that occur during the first exposure reoccur during later exposures. Ellis and Smith (1985) postulated that such sequences of fixations, called "scanpaths," are generated by either completely random, stratified random or statistically dependent stochastic processes. A completely random process, which assumes that each ad element has equal probability of being focussed during each fixation, provides little information about the attentional process and the attractiveness of ad elements. More information is obtained if eye movements are described by a stratified random (or a 0-order Markov) process, where the probabilities of ad elements being fixated reflect the attractiveness of those elements, but do not depend on information obtained during previous fixations. In view of the attentional and cognitive processes that are assumed to underlie eye movements (Henderson 1992; Stark and Ellis 1981), it is unlikely that saccades from one fixation point to another are generated by completely random or stratified-random processes. A statistically dependent stochastic process, on the other hand, specifies that the position of a fixation depends on previous fixations. Molnar and Ratsikas (1987) proposed that each next fixation's position only depends on the current fixation point, which implies that the dependence between successive fixations on ad elements follows a first-order Markov process. Ellis and Smith (1985) specify the statistically dependent stochastic process of eye movements in such a way that saccades from, say, ad element A to B occur as often as saccades from B to A. This means that the transition matrix describing the scanpath is symmetrical, or that the first-order Markov process is (time-)reversible (Ross 1996).

In addition, scanpath theory (Groner 1988; Noton and Stark 1975; Stark and Ellis 1981) predicts that a subject scans a new stimulus during the first exposure and stores the sequence of fixations in memory, so that a scanpath is established (Noton and Stark 1975). When the subject is exposed to the same stimulus again, the eyes tend to follow the same scanpath, which facilitates stimulus' recognition. Scanpath theory thus suggests that scanpaths are stationary across exposures. In empirical research to date (e.g., Groner and Menz 1985; Noton and Stark 1975), deterministic approaches to scanpaths have prevailed and the above postulates about the stochastic nature of scanpaths have remained untested. The present study tests the following hypotheses with respect to consumers' scanpaths:

H_{3a}: Fixations to the elements of a print advertisement depend on the location of the previous fixation, according to a first-order Markov process.

H_{3b}: Saccades between elements of a print advertisement are independent of the fixation order of the elements: the Markov process is reversible.

H_{3c}: The attentional scanpath, i.e., the distribution of saccades between elements of a print advertisement, remains constant across repeated exposures to the ad: the Markov process is stationary.

Robustness across stimulus and consumer characteristics

"Repetition effects are contingent on whether the ad persuades via emotional images or verbal arguments, whether initially it is a high or low scoring ad (for example, whether the verbal arguments are strong or weak), and whether or not consumers are motivated and able to process the ad" (Pechmann and Stewart 1989, p. 287). Building on the elaboration likelihood model (ELM; Petty and Cacioppo 1979; 1986) a sizable body of research has focused on the role of consumer motivation to process advertising and the arguments contained in the ad (e.g., Batra and Ray 1986; Celsi and Olson 1988; Miniard, Bhatla, and Rose 1990; Petty, Cacioppo, and Schumann 1983). The present study extends this research by examining the impact of motivation and argument quality on visual attention to repeated print advertisements, and the robustness of scanpaths across these two conditions.

With respect to motivation, Celsi and Olson (1988) found that highly motivated consumers pay more attention to ads, as measured by the total time consumers engage in processing the ads. Research so far has been limited to such general, global measures of attention, and has not considered local measures such as duration and onset of attention to specific ad elements and scanpaths across the ad elements, which are the focus of the present study. Celsi and Olson (1988) observed that attention of highly motivated subjects is mainly focussed on ad elements containing arguments instead of cues, but their conclusion was based on the proportion of thoughts that were product-related. In addition, the distinction between arguments and cues does not necessarily coincide with a distinction between textual and pictorial ad elements (Miniard et al. 1991; Unnava and Burnkrant 1991). Before engaging in a conceptual analysis where arguments and cues are evaluated with respect to quality and strength, consumers engage in perceptual and semantic analysis to extract the main features of the stimulus, and to understand the message (Greenwald and Leavitt 1984; Viviani 1990). Identification of ad elements containing arguments requires consumers to attend to and at least partially process the information within all elements. Highly motivated consumers will typically spend more effort on this identification process, leading to more attention to all ad elements. On the other hand, consumers' schemata about marketing and advertising tactics (Friestad and Wright 1994; Kirmani 1990) may indicate that textual elements contain arguments and pictorial elements contain cues (cf. Unnava and Burnkrant 1991). When we further take into account the fact that textual information requires more effort to process than visual information (Mitchell 1983), highly motivated consumers are likely to pay more attention to textual elements, while less motivated consumers are likely to pay more attention to pictorial elements (see also Kroeber-Riel 1993). Rosbergen, Pieters and Wedel (1997) found that the distribution of attention across ad elements depends on the antecedents of consumers' motivation to attend to the ad.

The effect of argument quality on visual attention to ad elements is even more difficult to predict beforehand. Celsi and Olson's (1988) results indicate that the effect of product-related arguments in an advertisement depends at least partially on consumer motivation. In addition, researchers testing ELM-based predictions about the impact of motivation and argument quality (e.g., Miniard, Bhatla, and Rose 1990; Petty and Cacioppo 1986; Petty, Cacioppo, and Schumann 1983) found that highly motivated consumers attach more importance to arguments than less motivated consumers, and that strong arguments have a positive effect whereas weak arguments have a negative effect on, for instance, product evaluations. These findings indicate that argument quality leads to differences in the outcomes of consumers' conceptual analyses of advertisements. Yet, it is not obvious that argument quality will also have effects on the content and outcomes of the perceptual analysis preceding the conceptual analysis (Greenwald and Leavitt 1984; Viviani 1990). No research to date has indicated that differences in product evaluations are actually caused by differences in consumers' visual attention to ad elements, in particular to textual elements. Therefore, this study explores the effect of argument quality of the perceptual analysis during repeated advertising exposure.

Finally, direct evidence regarding the effects of motivation and argument quality on consumers' scanpaths is absent. Molnar and Ratsikas' (1987) argued that "there are no differences between subjects in the statistical structure of visual exploration" (p. 371), implying that scanpaths do not differ systematically between subjects. They observed that many sequences of 3, 4 and sometimes 5 fixations were nearly identical for several subjects. Similarly, Groner and Menz (1985) found that scanpaths do not differ across subjects. The observed stability across subjects suggests that neither motivation nor argument quality affect consumers' scanpaths, but these relationships have not been experimentally tested before. This study is the first to examine the robustness of attentional processes, in particular scanpaths, across experimentally manipulated conditions of consumers' motivation and argument quality.

Data

Sixty-eight randomly selected consumers aged 19 to 52, who wore neither glasses nor contact lenses, were invited to come to the office of the market research company that conducted the experiment. The experiment lasted approximately half an hour, and subjects were paid the equivalent of twenty dollars for their participation.

Upon entering the experimental room, subjects received a booklet containing instructions regarding the experiment. They were instructed to carefully watch a series of slides of "draft versions" of print advertisements. The ads promoted eight different products: shampoo (shown three times), soup (three times), rice (twice), salad-dressing, sunburn lotion, sports shoes, garden furniture, and a vacuum cleaner. Half of the subjects were told that the study's purpose was to gain insight into the impact of information within ads on judgments about the products advertised, and they were promised a choice of shampoo at the end of the session (high motivation condition; MacKenzie and Spreng 1992). The other half were told that the purpose was to develop a new method for testing "draft versions" of advertisements, and that they were to evaluate the ads (low motivation condition).

The study's target ad, an ad for a non-existing brand of shampoo, Aquavital, appeared in the second, fourth and ninth position. Two versions of the ad were specially designed by an advertising agency. Both versions contained four elements (see Figure 1A): a headline, a pictorial, a packshot, and a bodytext with five textual arguments in favor of the product. The arguments were either strong (e.g., "The sea extracts in Aquavital provide natural nutrients essential to the strength and vitality of your hair") or weak (e.g., "It is suited to everyone's hair"), and the content of the headline was adjusted to the type of arguments used. Argument selection was based on the results of a pilot study, in which ten subjects evaluated a list of arguments on their believability, comprehensibility, originality, and strength (see Petty and Cacioppo 1986). The combination of headline and arguments was tested on its persuasive force.

Subjects were seated in front of a screen, on which the slides were projected from the back, and they were instructed to place their chin on a small chinrest. Eye positions were recorded fifty times a second by an infrared camera located at the subject's left side, such as not to interfere with normal viewing behavior (Young and Sheena 1975). The camera was trained on the subjects' right eye, and subjects performed a calibration task.

Before they were exposed to the thirteen ads, subjects were instructed to press a button in front of them to go through the ads at their own pace, but ads were shown to the subjects for twenty seconds at most.

After attending to the ads, subjects completed a questionnaire containing questions about their motivation to process the ad and the perceived quality of the arguments in the ad. Motivation to process the ad was measured by asking subjects to rate on a seven-point scale (completely agree−completely disagree) their motivation to evaluate the arguments listed in the ad. Argument quality was measured by having subjects rate the arguments on three seven-point items anchored by very convincing−not at all convincing, very weak−very strong, and not at all believable−very believable. All items ranged from +3 (highest) to -3 (lowest), and scores on the three items were averaged (coefficient alpha = 0.91).

Model

To examine the attentional process identified through eye movements, a model is developed that comprises three submodels for (1) attention duration per ad element; (2) attention onset for each ad element; and (3) inter- and intra-element saccade frequencies.

Gamma model for attention duration per ad element

Rosbergen, Pieters, and Wedel (1997) recently showed that attention durations defined as the number of seconds subject *i* attends to ad element *j* during exposure *r*, d_{ijr}, can be adequately described by a Gamma distribution:

$$f(d_{ijr}) = \frac{1}{\Gamma(\lambda)} \left[\frac{\lambda}{\tau_j^r}\right]^{\lambda} d_{ijr}^{\lambda-1} \exp\left[\frac{-\lambda d_{ijr}}{\tau_j^r}\right], \quad (1)$$

where τ_j^r represents the expected number of seconds subjects attend to ad element *j* during exposure *r*, and λ represents a dispersion parameter. The Gamma model is used to investigate differences in attention durations across exposures (H_1). In addition, the expected attention duration, τ_j^r, is modeled as a function of motivation and argument quality. More specific, we model $\ln(\tau_j^r)$ using a linear formulation represented by

[*ERMQ*], where *E* stands for Elements, *R* for Repetitions, *M* for Motivation, and *Q* for Quality of arguments (see, for instance, Agresti (1990) for the use of this notation). We estimate specific nested versions of the full model [*ERMQ*], which includes all interactions between *E*, *R*, *M*, and *Q*. In particular, support for H_1 is obtained when adding *R* improves the model's fit.

Censored-Gamma model for attention onset of advertising elements

Information regarding the order in which the ad elements are attended to can be obtained from the time that elapses between the start of the exposure to the ad and the start of the first eye fixation on the ad element. These attention onsets, represented by t_{ijr}, can be described using a censored-Gamma distribution with mean θ_j^r and dispersion parameter ρ. The distribution function $f(t_{ijr})$ is shown in equation (1), with parameters θ_j^r and ρ replacing τ_j^r and λ, respectively. We let T_{ir} denote the censoring time, which equals the total time the ad is attended to. Censoring becomes effective as soon as an ad element does not receive any attention during an exposure to the ad, and needs to be taken into account since negligence to deal with it may result in serious underestimation of the order effects. While the contribution to the likelihood of ad elements subjects attend to equals $f(t_{ijr})$, the contribution of elements that are not attended to during an exposure is represented by the survivor function:

(2) $$G(T_{ir}) = \int_{T_{ir}}^{\infty} f(t)\, dt.$$

To examine the impact of repetition, motivation, and argument quality on attention onset, we impose a log-linear structure on θ_j^r, i.e. $\ln(\theta_j^r) = [ERMQ]$, and test specific nested versions of this specification. H_2 is supported when adding *R* results in a better model fit.

Heterogeneous Markov model for attentional scanpaths (saccade frequencies)

The individual's attentional scanpath for an ad can be represented as a Markov chain on a directed graph, in which vertices represent eye fixations on ad elements and edges represent saccades between those elements (see Figure 1B).

INSERT FIGURE 1 ABOUT HERE

We represent the attentional scanpath by a stochastic model that comprises the probabilities that the subject's eyes move from ad element *j* to ad element *k*, $p_{k|j}$. We assume that scanpaths across ad elements can be described by a first-order Markov process. That is, each eye fixation only depends on the previous one, and for each subject *i* and each exposure *r*, $p^r_{k|j}$, the conditional probability that the subject's eyes move from ad element *j* to ad element *k*, is:

$$p^r_{k|j} = \frac{m_{jkr}}{\sum_{k=1}^{K} m_{jkr}}, \tag{3}$$

where m_{jkr} denotes the expected number of saccades from *j* to *k* during exposure *r*. Equation (3) is consistent with a Poisson process that produces the inter- and intra-element saccades, with expectation m_{jkr} (e.g., Lindsey 1995).

Rosbergen, Pieters, and Wedel (1997) demonstrated that research on visual attention should take heterogeneity between subjects into account. In this study, we account for inter-subject variability, or heteroscedasticity, in the expected number of saccades, m_{jkr}, by making the standard assumption that m_{jkr} is a random variable that follows a Gamma distribution with mean μ^r_{jk} and dispersion parameter ν^r_{jk} (McCullagh and Nelder 1989). In that case, the observed saccade frequencies, y_{ijkr}, follow a Negative Binomial distribution (NBD):

$$(4) \qquad f(y_{ijkr}) = \frac{\Gamma(y_{ijkr} + \nu^r_{jk})}{y_{ijkr}!\,\Gamma(\nu^r_{jk})} \left[\frac{\nu^r_{jk}}{\mu^r_{jk} + \nu^r_{jk}}\right]^{\nu^r_{jk}} \left[\frac{\mu^r_{jk}}{\mu^r_{jk} + \nu^r_{jk}}\right]^{y_{ijkr}}.$$

Although this model assumes that differences among subjects are random and can be represented by a Gamma distribution, we examine the presence of structural differences across the motivation and argument quality conditions as well.

In order to test H_3, we formulate the log-expectation and log-variance of the NBD, $\ln(\mu^r_{jk})$ and $\ln(\nu^r_{jk})$, as linear models [*FTRMQ*], where *F* denotes the rows in the transition matrix (*From*), *T* the columns (*To*), and *R*, *M* and *Q* are defined as above. Since the model is estimated on transition matrices aggregated across subjects, we include an offset in the model, ln(*N*), where *N* represents the number of subjects in the experimental groups. The hypotheses regarding the pattern of eye fixations and saccades are tested by comparing models that impose different nested structures, as is explained below.

First-order dependence. To test H_{3a}, the three possible stochastic processes that may underlie visual scanning of an ad are defined by different structures: [-] for the completely random process; [*F*,*T*] for the stratified random process, and [*FT*] for the statistically dependent process. The fact that visual scanning is a closed-circuit process, in the sense that the number of saccades starting from each ad element can differ from the number of saccades ending in that element by at most one, can be represented by *F*=*T*, i.e. the row-effect equals the column-effect.

Reversibility. H_{3b} postulates that the scanpath is reversible; i.e., the number of saccades from ad element *j* to *k*, $m_{jk} = p_{k|j}\, p_j$, is equal to the number of saccades from *k* to *j*, $m_{kj} = p_{j|k}\, p_k$ (Ross 1996), where p_j is the proportion of eye fixations directed at ad element *j*. Hence, reversibility within the scanpath can be tested by comparing the reversible Markov process characterized by a quasi-symmetric structure, [*F*,*T*,*S*], with an unrestricted Markov process, [*FT*]. Here, [*F*,*T*,*S*] is a model that, apart from the distorting effects of the marginal proportions defined by *F* and *T*, restricts the expectation of element (*j*,*k*) in the transition matrix to be equal to that of element (*k*,*j*) for all *k* and *j*.

The term S has as many levels as there are paired combinations (jk) and (kj) where j is unequal to k, and specifies each symmetric pair to have the same level (Lindsey 1995).

Stationarity. Scanpath theory (Groner 1988; Noton and Stark 1975; Stark and Ellis 1981) predicts that eye movements of subjects who are exposed repeatedly to the same ad involve patterns of fixations that remain constant across repetitions. That is, the Markov chain is stationary, and transition probabilities are constant across repetitions (H_{3c}). This stationary Markov process is characterized by [*FT,TR*] or by [*F,S,TR*] for the unrestricted and reversible processes, respectively. This model implies that the interaction effects *FR* and *FTR* (or *FR* and *SR* in case of the quasi-symmetry model) are zero (Lindsey 1995).

Robustness. Molnar and Ratsikas' (1987) conclusion that individuals essentially exhibit the same statistical structure of visual scanning, and thus have identical scanpaths, is investigated by testing the robustness of the scanpath across experimental conditions in which motivation and argument quality were manipulated. The terms M and Q are included in the linear model describing the log-expectation of the stochastic attention process, as well as their interactions with the terms of the scanpath model (F, T, R and/or S). This leads to the saturated model [*FTRMQ*], but specific nested version thereof are investigated as well.

Inter-subject variability. Finally, a model of the form [*ERMQ*] and restricted versions thereof are estimated for the log-variance parameter of the NBD, $\ln(\nu_{jk}^{r})$, to test for inter-subject variability, or heteroscedasticity (McCullagh and Nelder 1989), across the various assumed processes and experimental conditions. Significant contributions of E, R, M, or Q indicate that the variance about the expected number of saccades varies across ad elements, exposures, or subjects belonging to different experimental groups, respectively.

Model estimation and selection

All models are estimated with the method of maximum likelihood using computer programs written in Gauss (Aptech 1992). The optimal model specification for the

Gamma, the censored-Gamma and the Negative Binomial models is primarily determined by comparing nested models on the basis of the Consistent Akaike Information Criterion, *CAIC* (Bozdogan 1987; see also Rust et al. 1995), and likelihood ratio (*LR*) tests. The models that best describe attention durations, attention onsets, and scanpaths are obtained with stepwise procedures. Starting with the baseline model that contains only the intercept, at each stage we add a specific main or interaction effect, corresponding with the hypothesis tested, and compare the likelihood of the new model with the likelihood of the model in the previous stage. After the model describing the expected number of inter- and intra-element saccades is determined, we test whether the assumption of a constant variance can be uphold by adding terms to the model for the variance in a stepwise fashion.

Results

Manipulation and reliability checks. Analysis of variance shows that subjects in the high motivation condition score about one point higher on motivation to evaluate the arguments listed in the shampoo advertisement than subjects in the low motivation condition $(F_{1,64} = 4.22, p < 0.05)$. Manipulation of argument quality was successful as well, since strong arguments are indeed perceived as being stronger than weak arguments (0.59 versus -0.32; $F_{1,64} = 7.56, p < 0.05$).

Due to factors such as excessive blinking of the eye and tearfluid in the eye, reliability of the eye movement data of sixteen subjects is insufficient to include them in further analyses. The remaining 52 subjects are divided between the four conditions as shown in the Appendix. For each exposure, the following information was retained from the eye-tracking data: (1) attention duration per ad element defined as the sum of all fixation durations on the ad element; (2) attention onset per ad element defined as the time between the start of an exposure to the ad and the start of the first eye fixation on that ad element; and (3) a transition matrix containing the number of saccades between ad elements aggregated across subjects within the same experimental group (these matrices are listed in the Appendix).

Attention duration. Table 1 presents the results of the stepwise model selection procedure for the attention durations. It shows that Model 3, [*E*,*R*], provides the best representation of the data, because it yields the lowest value of the *CAIC*-statistic. This implies that attention durations differ significantly across ad elements (Model 2, [*E*], versus Model 1, [-]) and across exposures (Model 3 versus Model 2). The parameter estimates, which are displayed in Table 2, reveal that attention duration is longest for the text, followed by headline, and shortest for the pictorial and the packshot. In addition, a progressive decrease in the expected attention duration is observed across exposures, which supports H_1. The insignificant interaction effect *ER* (Model 4, [*ER*], versus Model 3; Table 1) indicates that the effect of repeated exposure is proportional across ad elements. Finally, Table 1 shows that neither motivation (Model 5, [*E*,*R*,*M*], versus Model 3) nor argument quality (Model 6, [*E*,*R*,*Q*], versus Model 3) affects the amount of attention paid to the ad elements.

INSERT TABLES 1 AND 2 ABOUT HERE

Attention onset. According to Table 3, which presents the results of the censored-Gamma model, Model 5, [*ER*,*M*], fits the data on attention onset best, since its *CAIC*-value is lowest. This implies that the time until subjects first fixate on the ad elements differs among elements (Model 2, [*E*], versus Model 1, [-]). Parameter estimates in Table 4 show that subjects attend first to the headline followed by the pictorial, the text, and finally the packshot. Although repetition as such has no impact on attention onset (Model 3, [*E*,*R*], versus Model 2; Table 3), differences in attention onset are not constant across exposures (Model 4, [*ER*], versus Model 3). As predicted by H_2, less time lies between the expected starts of the first fixations during the second and third exposure than during the first exposure. In other words, the attentional process accelerates during later exposures.

INSERT TABLES 3 AND 4 ABOUT HERE

Attention onset is also significantly affected by motivation (Model 5, [*ER*,*M*], versus Model 4; Table 3), in the sense that attention onsets are farther apart for highly motivated subjects than for less motivated subjects. However, motivation does not change the order in which ad elements are attended to for the first time substantially (although the *LR*-test of Model 6, [*ER*,*EM*], versus Model 5 is just significant, Table 3 shows that the *CAIC*-statistic is much higher for Model 6 than for Models 2, 4 and 5) nor does the impact of motivation on attention onset differ across exposures (Model 7, [*ER*,*RM*], versus Model 5; Table 3). Argument quality, on the other hand, does not influence the moment subjects first attend to ad elements (Model 8, [*ER*,*M*,*Q*], versus Model 5).

Scanpaths. Table 5 presents the results of the model selection procedure for the Markov scanpath models estimated on the transition matrices. The significant improvement in fit from Model 1, [-], to Model 2, [*F*,*T*], indicates that the selection of fixation points cannot be regarded as being completely random. Moreover, support is obtained for a closed-circuit process (Table 5, *CAIC* of Model 3: [F,T^*] with $F=T^*$ versus Model 2).

INSERT TABLE 5 ABOUT HERE

As can be concluded from Table 5, adding a main effect for repetition to the model significantly improves the model's fit (Model 4, [F,T^*,R], versus Model 3). This supports the hypothesis that attention duration is affected by repeated exposure, H_1, since the repetition main effect indicates that the total number of fixations differs significantly across exposures. On the other hand, neither motivation nor argument quality (Models 5 and 6, respectively) significantly affect the attentional process, which demonstrates the robustness of the scanpath to be described across experimental conditions.

Next, we investigated whether visual scanning of an ad represented by its scanpath is a first-order, reversible Markov process as suggested by H_{3a} and H_{3b}, respectively. First, as indicated by the highly significant *LR*-test for Model 7, [FT^*,R], versus Model 4 and the associated drop in *CAIC*, there is a very strong dependence of successive fixations on ad elements. Thus, the evidence for a first-order Markov process is overwhelming (H_{3a} supported). Reversibility of this process, in turn, requires that model fit does not decrease significantly when we impose a quasi-symmetric (Model 8: [F,T^*,R,S]) instead of an unrestricted Markov structure (Model 7). Table 5 shows that Model 8 provides a much better representation of the saccade frequencies than Model 4. Moreover, comparison of Models 7 and 8 indicates that the quasi-symmetric model fits the data as well as the unrestricted model, and that, in fact, the information statistic, *CAIC*, is lowest for the quasi-symmetric model. This implies that the scanpath is indeed reversible, which supports H_{3b}.

To examine whether scanpaths are stable across repeatedly shown print ads as well, we test the significance of the contributions of the interaction effects *FR* (Model 9: $[FR,T^*,S]$) and *RS* (Model 10: $[F,T^*,RS]$) on the expected number of saccades. Since neither of these effects leads to a significant improvement in fit, our hypothesis that the stochastic scanpath is stationary across exposures, H_{3c}, is supported.

To test for inter-subject variability, we employ a stepwise selection procedure for the log-variance parameter, $\ln(\nu^r_{jk})$. Comparison of Model 11, $[E]_\nu$, and Model 8 shows that the variance parameter differs between ad elements. Adding further effects to the model for $\ln(\nu^r_{jk})$, Models 12 through 14, does not improve the model contribute significantly, which indicates that variances do not differ across repetitions and experimental groups.

Parameter estimates for the selected model, Model 11, are presented in Table 6. The estimates show that subjects pay more attention to the ad during the first exposure than during later exposures. Further, bodytext, headline, packshot and pictorial receive a decreasing amount of attention in that order. Both results confirm the results of the Gamma model for attention duration (Table 2). Table 6 also shows that, compared to the other elements, subjects appear to be most heterogeneous with respect to their attention to the bodytext.

INSERT TABLE 6 AND 7 ABOUT HERE

In sum, the ad's scanpath can be described by a reversible, stationary first-order Markov process. In Table 7, we present the expected transition matrices calculated on the basis of the parameter estimates in Table 6. Table 7 shows that (1) the amount of attention paid to the text is about three times as high as the amount paid to the pictorial; (2) the amount of attention paid to the ad decreases by about 50 per cent from exposure 1 to exposure 3; (3) the majority of saccades, about 75%, occur within ad elements, in particular in the bodytext; (4) most inter-element saccades start from or end at the packshot; (5) the expected transition matrices are quasi-symmetric; and (6) the conditional transition probabilities represented by the arrows in Figure 1B remain constant across exposures. The steady state probabilities corresponding to those transition probabilities (Winston 1987) indicate that, in the long run, the probability that subjects' eyes move to a specific ad element becomes constant and equals 0.19 for the headline, 0.13 for the pictorial, 0.50 for the bodytext, and 0.18 for the packshot.

Combining the results of the three submodels yields the following picture: As the attention onsets show, subjects attend, on average, first to the headline. As indicated by the expected number of saccades between headline and pictorial, attention is then directed to the pictorial. However, the attention onsets provide some indication that during later exposures this order may be reversed. Both headline and pictorial receive about one-sixth of subjects' attention. Half of the attention is directed at the bodytext, but subjects focus on the bodytext only after the headline and the pictorial have received some initial attention. Finally, we see that subjects attend to the packshot last, and that, despite the limited amount of attention spent on this ad element, most intra-element saccades start from and end at the packshot. This may point to integration of information in other ad elements with information in the packshot.

Discussion

Whereas previous research based on the two-factor theory (Berlyne 1970; Cacioppo and Petty 1979) has concentrated on the effects of repeated TV-advertising on overall memory and evaluation measures such as recall and ad liking, this study examined the impact of repetition on visual attention to specific elements of a print advertisement, using eye-tracking data. In support of our hypotheses, we found that repetition reduces the amount of attention paid to the ad and its elements by about 50 per cent, and increases the speed, but does not change the order of scanning the ad elements substantially. Further, we established the existence of consumers' attentional scanpaths that can be described by a reversible first-order Markov process. This Markov process is stationary across exposures, as predicted by scanpath theory (Groner 1988; Noton and Stark 1975; Stark and Ellis 1981). The stability of the (stochastic) scanpath across repeated exposures is particularly striking, because it indicates that consumers' attentional process is largely determined during the first exposure and is very difficult to change during subsequent exposures.

Our results attest to the importance of attention in understanding the mechanisms of how advertising works. In particular, the repeated exposures of consumers to the same ad enabled us to identify the effects of satiation, due to which attention decreased by 50% over three repeated exposures, while not affecting the scanpath itself. This result indicates that if consumers control exposure duration themselves, such as with print advertising, they will adapt exposure duration to limit satiation. On the other hand, the satiation effect may be much larger with externally paced television commercials. Of course, consumers can adapt their attention during repeated exposures to a commercial by zapping to another channel (Olney, Holbrook, and Batra 1991) or by mentally tuning out during the exposure (Goodstein 1993), but such activities concern a decision to interrupt an externally paced commercial and not to accelerate their attention, as with print ads.

The results of this study further indicated that satiation cannot be postponed through the quality of the arguments listed in the advertisement. Specifically, argument quality does not moderate the effect of repetition on any aspect of visual attention. Apparently, consumers attend to strong and weak arguments equally. Finally, in this study motivation had no effect on attention duration, the order in which ad elements are attended to, nor the scanpath along the elements, but it did affect attention onset.

Future research

Besides replication of this study using advertisements for different products placed in several advertising media, another potential avenue for future research concerns the determinants and consequences of the attentional scanpath. The first-order Markov process describing this scanpath indicates that information obtained during the current fixation is used to determine the focus of the next fixation. Though this suggests that cognitive processes underlie visual attention to a print ad, our study did not explicitly examine whether these processes are top-down, subject-driven or bottom-up, stimulus-driven (Van der Heijden 1992). That is, a scanpath may be the joint outcome of (1) consumers' schemata learned through repeated daily exposure to advertising about the dominant architecture of print ads in general, or ads in this specific medium or for this specific product/brand (e.g., Friestad and Wright 1994; Kirmani 1990), and (2) specific ad characteristics that attract and guide attention, such as contrast, letter and picture size, and so forth. The fact that no individual differences in the scanpaths were found, while the ad layout exerted a strong effect seems to support the hypothesis of a stimulus-driven process, where schemata play an important role in the attentional process. However, little research on schemata and ad characteristics in attentional processes has been performed, despite the focus on the role and impact of attracting and guiding attention in advertising research (Aaker, Batra, and Myers 1992; Kroeber-Riel 1993). Future studies using, for example, advertisements with varying architectures could provide more insight into the relative importance of subject- versus stimulus-specific determinants of scanpaths.

Another important question is whether certain scanpaths contribute more to advertising effectiveness than others. Assuming equal attention durations, does it matter how, for instance, a consumer scans two different ads? According to scanpath theory, the scanpath facilitates subsequent recognition of advertisements and thus of advertised brands. Therefore, research on scanpaths should not only examine regularities in eye movements, but also their effects on, for instance, subjects' cognitive responses and advertising recall (Viviani 1990). More insight into this relationship could be obtained by examining differences in scanpaths and recall scores across advertisements for different products and with different layouts.

A potential limitation of our study is the short intervals between ad exposures, which may have led to higher stability of the attentional scanpath. On the other hand, impact scheduling, i.e. repeating the same advertisement multiple times within the same print issue or commercial block, is a common strategy nowadays. Moreover, our research setting is a typical "pretest" situation to examine the quality of a new ad and the impact of repeating the ad several times within a short time frame, and inter-exposure intervals closely resemble those used in previous studies on advertising repetition (e.g., Burke and Srull 1988; Cacioppo and Petty 1980; Ray and Sawyer 1971; Schumann, Petty, and Clemons 1990). Examining visual attention and scanpaths under different experimental conditions, using various ads for different brands in different media, and using longer inter-exposure intervals will enlarge insights into the effects of advertising repetition.

Finally, in line with Groner and Menz' (1985) and Molnar and Ratsikas' (1987) results, we found that the attentional scanpath was not affected by motivation. In addition, motivation did not affect attention duration in this study. On the other hand, Celsi and Olson (1988) observed that higher motivation leads to longer attention duration, but subjects participating in their experiment paid, on average, significantly more attention to the advertisement than subjects participating in our experiment (i.e., 50.1 seconds compared to 13.5 seconds for the first exposure in our experiment), and differences between subjects were much larger. This increases the likelihood of observing significant differences across experimental groups. However, the conclusions Celsi and Olson drew might be improper, because the analyses of variance they are based on implicitly assume a Normal distribution for attention duration, whereas a Gamma distribution is more appropriate (Rosbergen, Pieters, and Wedel 1997). Hence, future research should examine in more detail the moderating role of a large number of relevant consumer characteristics, such as prior knowledge, familiarity and motivation, on the effects of repetition on attention.

APPENDIX: NUMBER OF SACCADES BETWEEN AD ELEMENTS

	Exposure 1					Exposure 2					Exposure 3				
	High		Low			High		Low			High		Low		
Saccade[A]	S[A]	W	S	W	Tot.	S	W	S	W	Tot.	S	W	S	W	Tot.
Hline ➜ Hline	117	74	73	75	339	66	73	39	48	226	32	33	19	42	126
Hline ➜ Pict	13	7	11	14	45	7	7	14	12	40	5	4	10	10	29
Hline ➜ Text	2	3	2	1	8	2	1	1	1	5	1	2	0	2	5
Hline ➜ Pack	12	7	9	9	37	5	7	5	7	24	3	7	3	2	15
Pict ➜ Hline	9	4	8	9	30	6	2	5	9	22	4	3	6	5	18
Pict ➜ Pict	38	19	37	56	150	22	18	16	46	102	23	16	14	36	89
Pict ➜ Text	9	3	7	7	26	6	6	7	6	25	3	2	11	3	19
Pict ➜ Pack	13	9	10	14	46	3	5	7	18	33	4	4	6	18	32
Text ➜ Hline	1	0	0	0	1	3	0	3	0	6	0	0	2	1	3
Text ➜ Pict	11	6	9	10	36	3	2	7	9	21	5	3	4	8	20
Text ➜ Text	275	324	345	346	1290	172	229	71	139	611	50	112	67	90	319
Text ➜ Pack	16	21	12	23	72	13	15	8	11	47	7	13	3	6	29
Pack ➜ Hline	19	15	19	19	72	9	14	14	14	51	9	11	9	11	40
Pack ➜ Pict	16	6	10	11	43	8	7	7	20	42	5	4	12	17	38
Pack ➜ Text	18	23	15	26	82	15	14	14	14	55	10	11	2	11	37
Pack ➜ Pack	44	54	42	63	203	15	22	48	48	110	22	48	15	48	104
N	12	11	15	14	52	12	11	15	14	52	12	11	15	14	52

[A] Hline = Headline; Pict = Pictorial; Text = Text; and Pack = Packshot

[B] High = High motivation; and Low = Low motivation

[C] S = Strong arguments; and W = Weak arguments

TABLE 1

SELECTION RESULTS OF THE GAMMA MODEL FOR ATTENTION DURATIONS

Model	**ln(*L*)**	***CAIC***	***LR***	***#df***
1. [-]	-1050.00	2114.87		
2. [*E*]	-957.39	1951.96	185.23*	3
3. [*E*,*R*]	-922.16	1896.36	70.46*	2
4. [*ER*]	-916.35	1929.37	11.62	6
5. [*E*,*R*,*M*]	-920.40	1900.29	3.52	1
6. [*E*,*R*,*Q*]	-920.65	1900.79	3.40	1

* significant at $p < 0.01$.

TABLE 2

PARAMETER ESTIMATES FOR THE SELECTED GAMMA MODEL FOR ATTENTION DURATIONS

Parameter	**Estimate**	**Standard Deviation**
Intercept	-0.409*	0.097
E (headline)	0.311*	0.116
E (pictorial)	0.201	0.115
E (bodytext)	1.378*	0.116
R (1)	0.861*	0.101
R (2)	0.382*	0.100
λ	-0.039	0.047

* significant at $p < 0.01$.

TABLE 3

SELECTION RESULTS OF THE CENSORED-GAMMA MODEL FOR ATTENTION ONSET

Model	**ln(*L*)**	***CAIC***	***LR***	***#df***
1. [-]	-702.10	1419.08		
2. [*E*]	-652.49	1342.16	99.22*	3
3. [*E*,*R*]	-651.83	1355.72	1.32	2
4. [*ER*]	-621.39	1339.46	60.88*	6
5. [*ER*,*M*]	-614.75	1333.60	13.28*	1
6. [*ER*,*EM*]	-608.83	1344.07	11.84*	3
7. [*ER*,*RM*]	-612.21	1343.39	5.08	2
8. [*ER*,*M*,*Q*]	-614.59	1340.72	0.32	1

* significant at $p < 0.01$.

TABLE 4

PARAMETER ESTIMATES FOR THE SELECTED CENSORED-GAMMA MODEL FOR ATTENTION ONSET

Parameter	**Estimate**	**Standard Deviation**
Intercept	0.726**	0.218
E (headline)	-1.278**	0.432
E (pictorial)	-0.662*	0.329
E (bodytext)	-0.226	0.411
R (1)	0.700*	0.298
R (2)	0.154	0.195
M (high)	0.463**	0.136
E·*R* (headline,1)	-2.360**	0.592
E·*R* (pictorial,1)	0.096	0.491
E·*R* (bodytext,1)	-0.184	0.484
E·*R* (headline,2)	-0.038	0.793
E·*R* (pictorial,2)	-0.214	0.367
E·*R* (bodytext,2)	-0.018	0.423
ρ	0.608**	0.051

* significant at $p < 0.05$.
** significant at $p < 0.01$.

TABLE 5

SELECTION RESULTS OF THE MARKOV SCANPATH MODEL FOR SACCADE FREQUENCIES

Model	**ln(*L*)**	***CAIC***	***LR***	***#df***
1. [-]	-786.53	1585.57		
2. [F,T]	-766.82	1583.71	39.42*	6
3. [F,T^*], F=T^*	-767.17	1565.64	-0.70	-3
4. [F,T^*,R]	-760.72	1565.24	12.90*	2
5. [F,T^*,R,M]	-760.53	1571.12	0.38	1
6. [F,T^*,R,Q]	-759.87	1569.79	1.70	1
7. [FT^*,R]	-645.96	1392.03	229.52*	9
8. [F,T^*,R,S]	-647.67	1376.69	-3.42	-3
9. [FR,T^*,S]	-646.50	1411.89	2.34	6
10. [F,T^*,RS]	-645.76	1447.97	3.82	12
11. $[E]_v$	-577.63	1255.38	140.08*	3
12. $[E,R]_v$	-563.82	1277.82	2.38	2
13. $[E,M]_v$	-573.93	1273.00	0.74	1
14. $[E,Q]_v$	-575.84	1276.83	0.02	1

* significant at $p < 0.01$.

TABLE 6

PARAMETER ESTIMATES FOR THE STATIONARY, REVERSIBLE SCANPATH MODEL

Parameter	**Estimate**	**Standard Deviation**
μ:		
Intercept	0.667*	0.101
F=T^* (headline)	0.243*	0.065
F=T^* (pictorial)	-0.094	0.063
F=T^* (bodytext)	0.803*	0.193
R (1)	0.588*	0.083
R (2)	0.244*	0.086
S (headline,pictorial)	-1.663*	0.118
S (headline,bodytext)	-4.285*	0.304
S (headline,packshot)	-1.454*	0.120
S (pictorial,bodytext)	-2.466*	0.233
S (pictorial,packshot)	-1.154*	0.104
S (bodytext,packshot)	-1.688*	0.218
ν:		
Intercept	0.241	0.440
E (headline)	-0.431	0.498
E (pictorial)	-0.026	0.195
E (bodytext)	-3.329*	0.455

* significant at $p < 0.01$.

TABLE 7

EXPECTED NUMBER OF SACCADES PER SUBJECT

	From	Hline	Pict.	Btext	Pshot	*Fixation frequency*
Exp. 1	Headline	**5.70**	0.77	0.14	1.04	7.66
	Pictorial	0.77	**2.91**	0.61	1.01	5.29
	Bodytext	0.14	0.61	**17.48**	1.45	19.67
	Packshot	1.04	1.01	1.45	**3.51**	7.01
Exp. 2	Headline	**4.04**	0.55	0.10	0.74	5.43
	Pictorial	0.55	**2.06**	0.43	0.71	3.75
	Bodytext	0.10	0.43	**12.39**	1.03	13.94
	Packshot	0.74	0.71	1.03	**2.49**	4.97
Exp. 3	Headline	**3.17**	0.43	0.08	0.58	4.25
	Pictorial	0.43	**1.61**	0.34	0.56	2.94
	Bodytext	0.08	0.34	**9.71**	0.80	10.93
	Packshot	0.55	0.56	0.80	**1.95**	3.89

Note: Hline, Pict., Btext and Pshot are grouped under the spanning header *To*.

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